(12) UK Patent Application (19) GB (11) 2 312 059 (13) A

(43) Date of A Publication 15.10.1997

(21) Application No 9607692.2

(22) Date of Filing 12.04.1996

(71) Applicant(s)
Sony United Kingdom Limited

(Incorporated in the United Kingdom)

The Heights, Brooklands, WEYBRIDGE, Surrey, KT13 0XW, United Kingdom

(72) Inventor(s)
Jonathan Mark Greenwood
Mark John McGrath

(74) Agent and/or Address for Service
D Young & Co
21 New Fetter Lane, LONDON, EC4A 1DA, United Kingdom

(51) INT CL[6]
G11B 20/12, G06F 12/02 // G11B 27/034

(52) UK CL (Edition O)
G4A AMG2
U1S S2101 S2102 S2106

(56) Documents Cited
GB 2218833 A EP 0452884 A2 EP 0416445 A2
EP 0328240 A2
P Norton et al, "The New Peter Norton Programmer's Guide to The IBM PC & OS/2", 1988, pp 118-121
Dialog record 01373292 of UNIX Review, v8, n10, Oct 90, Fros t L, "UNIX file recovery", p73(7)

(58) Field of Search
UK CL (Edition O) G4A AMG2 AMX
INT CL[6] G06F 12/02 12/06, G11B 20/12 27/031 27/034
On-line: WPI, Inspec, Computer

(54) **Data storage free space management**

(57) Data storage apparatus having an ordered data array of data items stored on a storage medium, in which deletion of a data item from the array leaves data storage space in which a newly stored data item can be stored, comprises means for storing a mask array on the storage medium, the mask array having a respective mask array entry for each possible data item position in the stored data array, which is settable to indicate whether a data item is validly stored at that data array position. As described the data array is a file header table, each entry in the table having associated with it one or more bits in the mask array. The medium may be a magnetic or magneto-optical disk. The invention is applicable in a digital video editing system (Fig. 1).

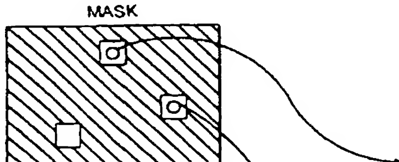


FIG. 12A

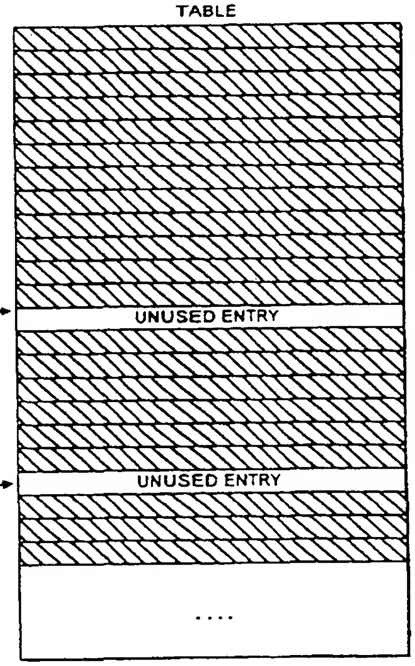
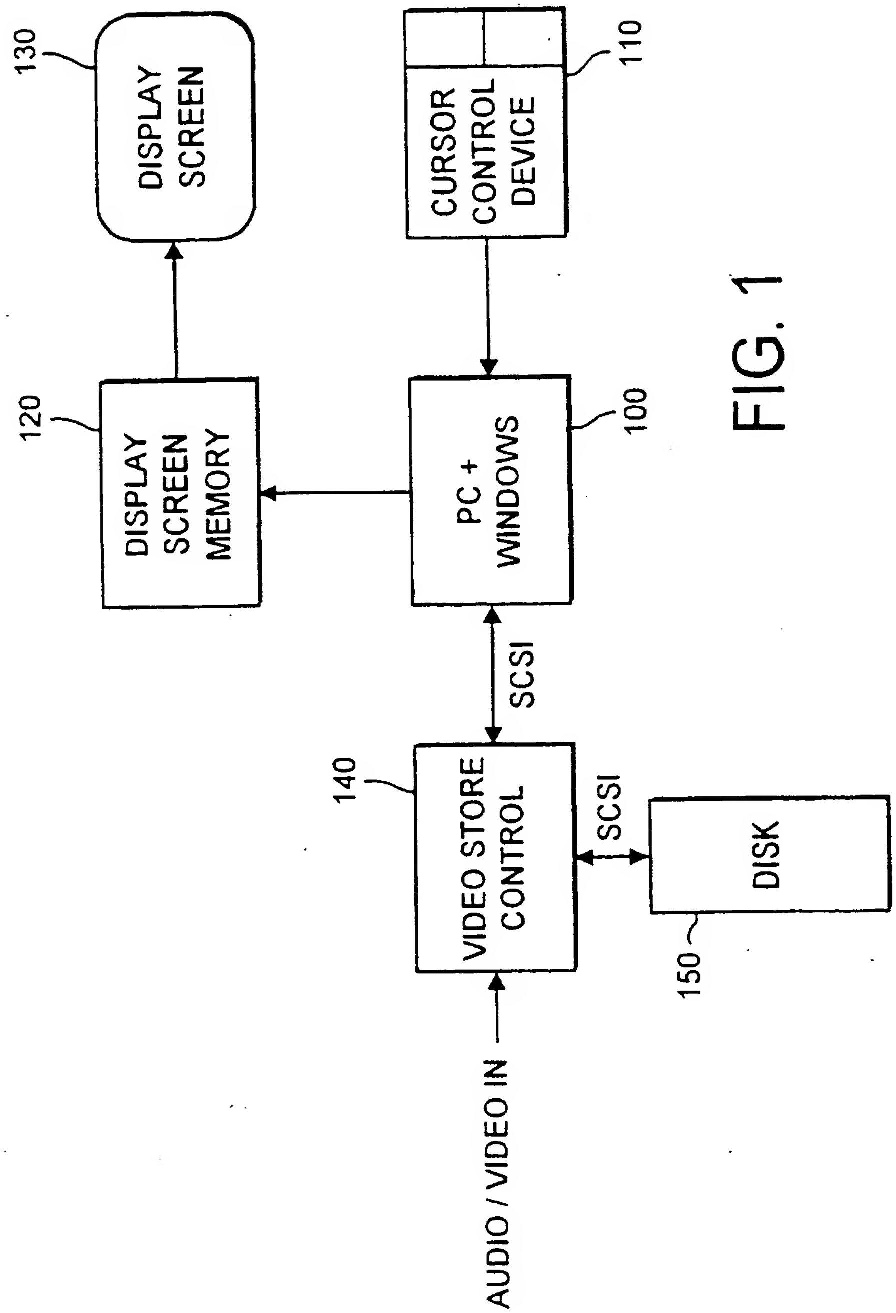


FIG. 12B

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 312 059 A



130
DISPLAY SCREEN
110
CURSOR CONTROL DEVICE
120
DISPLAY SCREEN MEMORY
100
PC + WINDOWS
SCSI
140
VIDEO STORE CONTROL
SCSI
DISK
150
AUDIO / VIDEO IN

FIG. 1

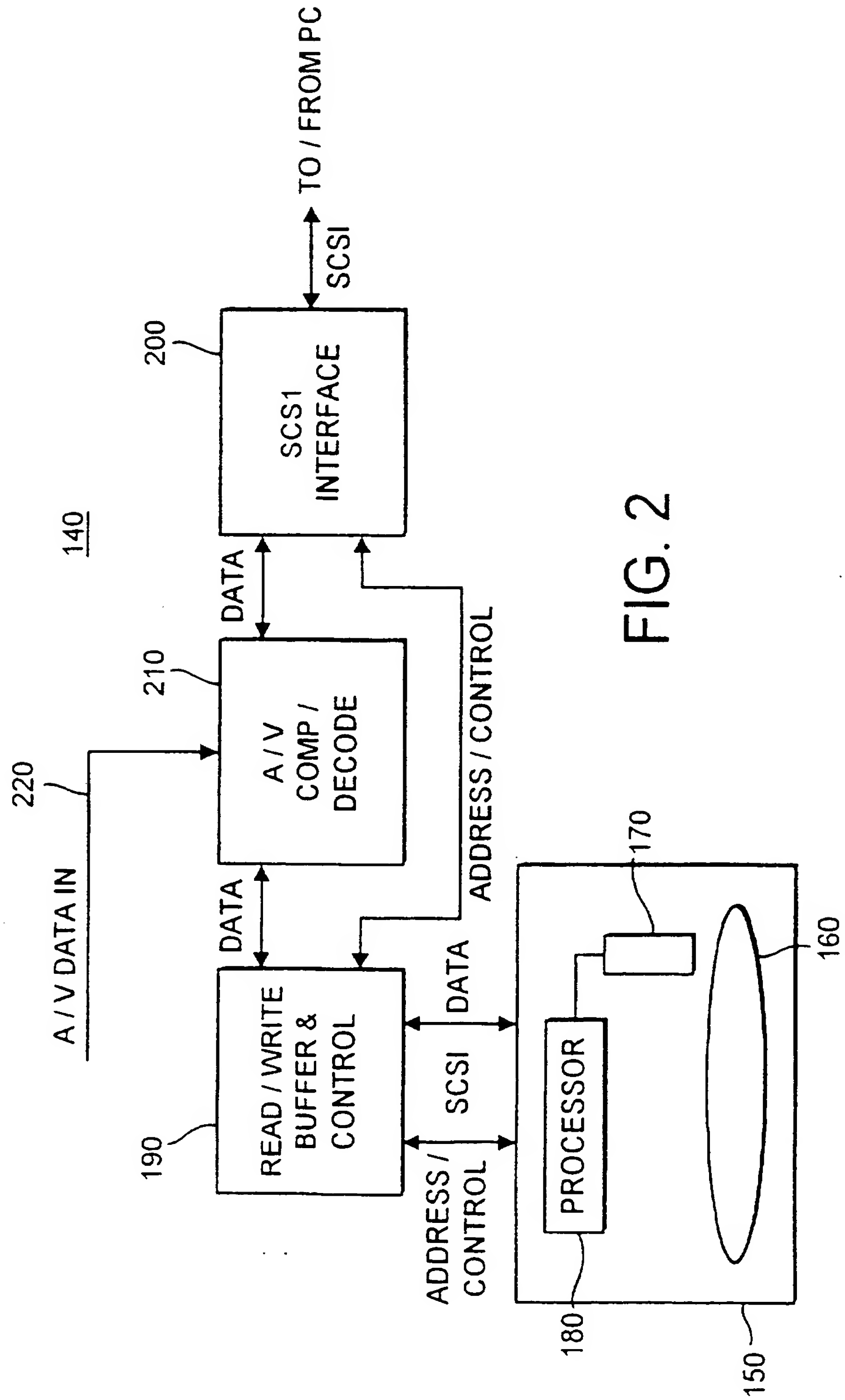

140
TO / FROM PC
SCSI
200
SCS1 INTERFACE
DATA
210
A / V COMP / DECODE
220
A / V DATA IN
DATA
ADDRESS / CONTROL
190
READ / WRITE BUFFER & CONTROL
DATA
SCSI
ADDRESS / CONTROL
170
160
PROCESSOR
180
150

FIG. 2

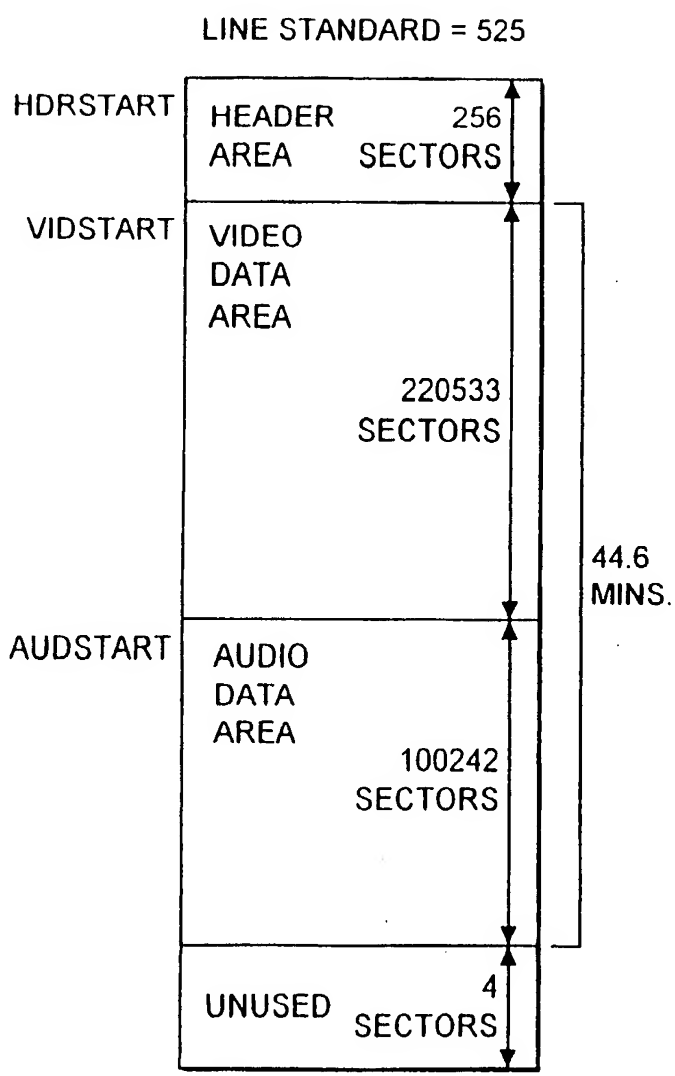

LINE STANDARD = 525
HDRSTART
HEADER AREA
256 SECTORS
VIDSTART
VIDEO DATA AREA
220533 SECTORS
AUDSTART
AUDIO DATA AREA
100242 SECTORS
UNUSED
4 SECTORS
44.6 MINS.

FIG. 3A

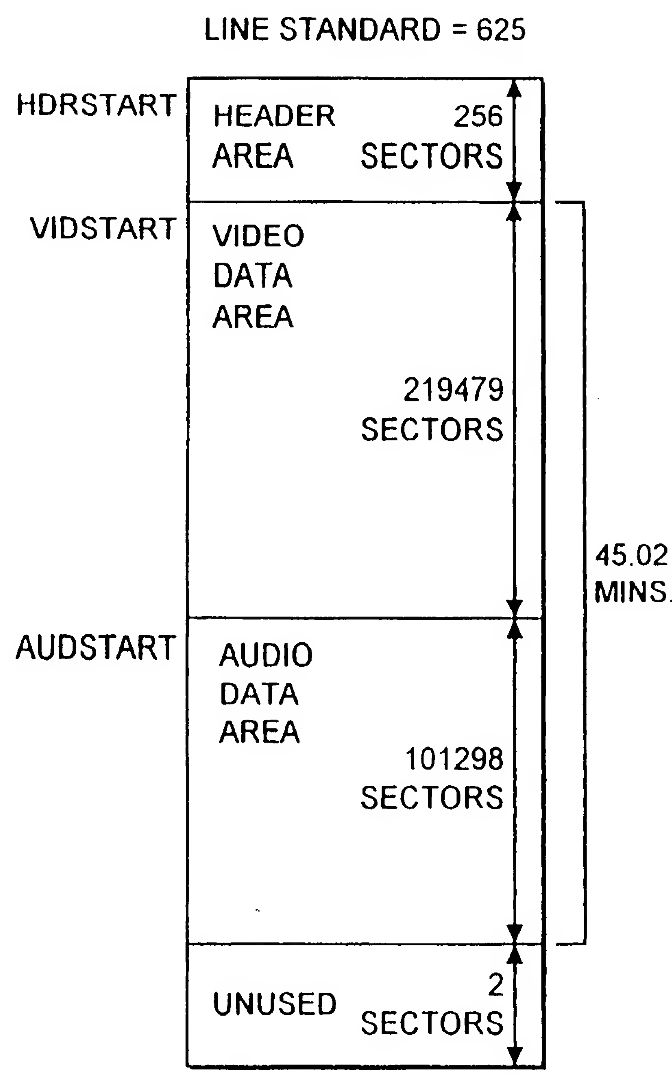

LINE STANDARD = 625
HDRSTART
HEADER AREA
256 SECTORS
VIDSTART
VIDEO DATA AREA
219479 SECTORS
AUDSTART
AUDIO DATA AREA
101298 SECTORS
UNUSED
2 SECTORS
45.02 MINS.

FIG. 3B

LBA	OFFSET	#BYTES	#LBS	DATA
32			1	DISK HEADER
33		32	1	REAL FILE MASK
34			2	REAL FILE NAME TABLE (RFNT)
36			16	REAL FILE HEADER TABLE (RFHT)
52		32	1	VIRTUAL FILE MASK
53			2	VIRTUAL FILE NAME TABLE (VFNT)
55			16	VIRTUAL FILE HEADER TABLE (VFHT)
71			64	ROUTE MAP (RM)
135		1024	1	VET MASK
136			64	VIDEO EDIT TABLE (VET)
200		1024	1	AET MASK
201			64	AUDIO EDIT TABLE (AET)
265			23	UNUSED

FIG. 4

RECORD INDEX	# BYTES	7	6	5	4	3	2	1	0
0	16	- UNUSED -							
1	16	FILENAME (15+1 CHARS)							
2	16	FILENAME (15+1 CHARS)							
3...		etc							

FIG. 6

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	33	FORMAT ID e.g. 'DNE-50' (32+1 CHARS)							
	33	FORMAT VERSION e.g. 'V1.01' (32+1 CHARS)							
	33	PC SOFTWARE VERSION e.g. 'V1.02' (32+1 CHARS)							
	33	EMBEDDED FIRMWARE VERSION e.g. 'V1.02' (32+1 CHARS)							
	33	DISK VOLUME LABEL (32+1 CHARS)							
	1	NUMBER OF REAL FILES ON DISK							
	1	NUMBER OF VIRTUAL FILES ON DISK							
	2	NUMBER OF FRAGMENTS ON DISK (ROUTE MAP ENTRIES)							
	2	START OF FREE SPACE (ROUTE MAP INDEX)							
	2	END OF FREE SPACE (ROUTE MAP INDEX)							
	1	- UNUSED -							LINE STANDARD
..2047		- UNUSED -							

FIG. 5

1 RECORD

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	16	FILE NAME (15+1 CHARS)							
	11	CREATION DATE 'DD/MM/YYYY' (10+1 CHARS)							
	9	CREATION TIME 'HH:MM:SS' (8+1 CHARS)							
	4	TIMECODE START							
	4	NUMBER OF FRAMES							
	2	NUMBER OF FRAGMENTS							
	2	FIRST ENTRY IN ROUTE MAP (ROUTE MAP INDEX)							
	2	LAST ENTRY IN ROUTE MAP (ROUTE MAP INDEX)							
	64	NOTES (63+1 CHARS)							
	4	HEAD PICTURE FRAME							
	4	TAIL PICTURE FRAME							
	1					CH 4	CH 3	CH 2	CH 1
	5	UNUSED (PAD TO 128 BYTES / HEADER)							
		NEXT FILE HEADER RECORD							

FIG. 7

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	16	FILE NAME (15+1 CHARS)							
	11	CREATION DATE 'DD/MM/YYYY' (10+1 CHARS)							
	9	CREATION TIME 'HH:MM:SS' (8+1 CHARS)							
	4	TIMER PRESET							
	4	NUMBER OF FRAMES							
	2	NUMBER OF ENTRIES IN VET							
	2	FIRST ENTRY IN VET (VIDEO EDIT TABLE INDEX)							
	2	NUMBER OF ENTRIES IN AET							
	2	FIRST ENTRY IN AET (AUDIO EDIT TABLE INDEX)							
	64	NOTES (63+1 CHARS)							
	4	HEAD PICTURE FRAME							
	4	TAIL PICTURE FRAME							
	1					CH 4	CH 3	CH 2	CH 1
	3	UNUSED (PAD TO 128 BYTES / HEADER)							
		NEXT FILE HEADER RECORD							

1 RECORD

FIG. 8

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	4	PACKET NUMBER OF START FRAGMENT #1 (PACKET NUMBER)							
	4	LENGTH OF FRAGMENT #1 (#FRAMES)							
	2	NEXT ROUTE MAP RECORD (ROUTE MAP INDEX)							
	6	UNUSED							
	4	PACKET NUMBER OF START FRAGMENT #2 (PACKET NUMBER)							
	4	LENGTH OF FRAGMENT #2 (#FRAMES)							
	2	NEXT ROUTE MAP RECORD (ROUTE MAP INDEX)							
	6	UNUSED							
		etc....							

FIG. 9

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	1	REAL FILE NUMBER							
	2	START IN THE ROUTE MAP (ROUTE MAP INDEX)							
	4	OFFSET FROM START (FRAMES)							
	4	LENGTH (FRAMES)							
	2	NEXT VET RECORD (VIDEO EDIT TABLE)							
	3	- UNUSED -							
		etc...							

FIG. 10

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	1	REAL FILE NUMBER							
	2	START IN THE ROUTE MAP (ROUTE MAP INDEX)							
	4	OFFSET FROM START (FRAMES)							
	4	LENGTH (FRAMES)							
	2	NEXT AET RECORD (AUDIO EDIT TABLE)							
		CHANNEL 4 LEFT	CHANNEL 3 LEFT	CHANNEL 2 LEFT	CHANNEL 1 LEFT	CHANNEL 4 RIGHT	CHANNEL 3 RIGHT	CHANNEL 2 RIGHT	CHANNEL 1 RIGHT
	2	- UNUSED -							
		etc...							

FIG. 11

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	1	HEADER							
	32	TIMECODE							
	1	CH1 BIT 11	CH1 BIT 10	CH1 BIT 9	CH1 BIT 8	CH1 BIT 7	CH1 BIT 6	CH1 BIT 5	CH1 BIT 4
	1	CH1 BIT 3	CH1 BIT 2	CH1 BIT 1	CH1 BIT 0	CH2 BIT 11	....	....	....
	1	....	....	....	....	....	....	....	CH2 BIT 0
	1	CH3 BIT 11	....	....	....	....	....	....	....
	1	....	....	....	CH3 BIT 0	CH4 BIT 11	....	....	....
	1	....	....	....	....	....	....	....	CH4 BIT 0
	.	OTHER AUDIO SAMPLES							
	..	- UNUSED -							
		NEXT FRAME							

FIG. 13

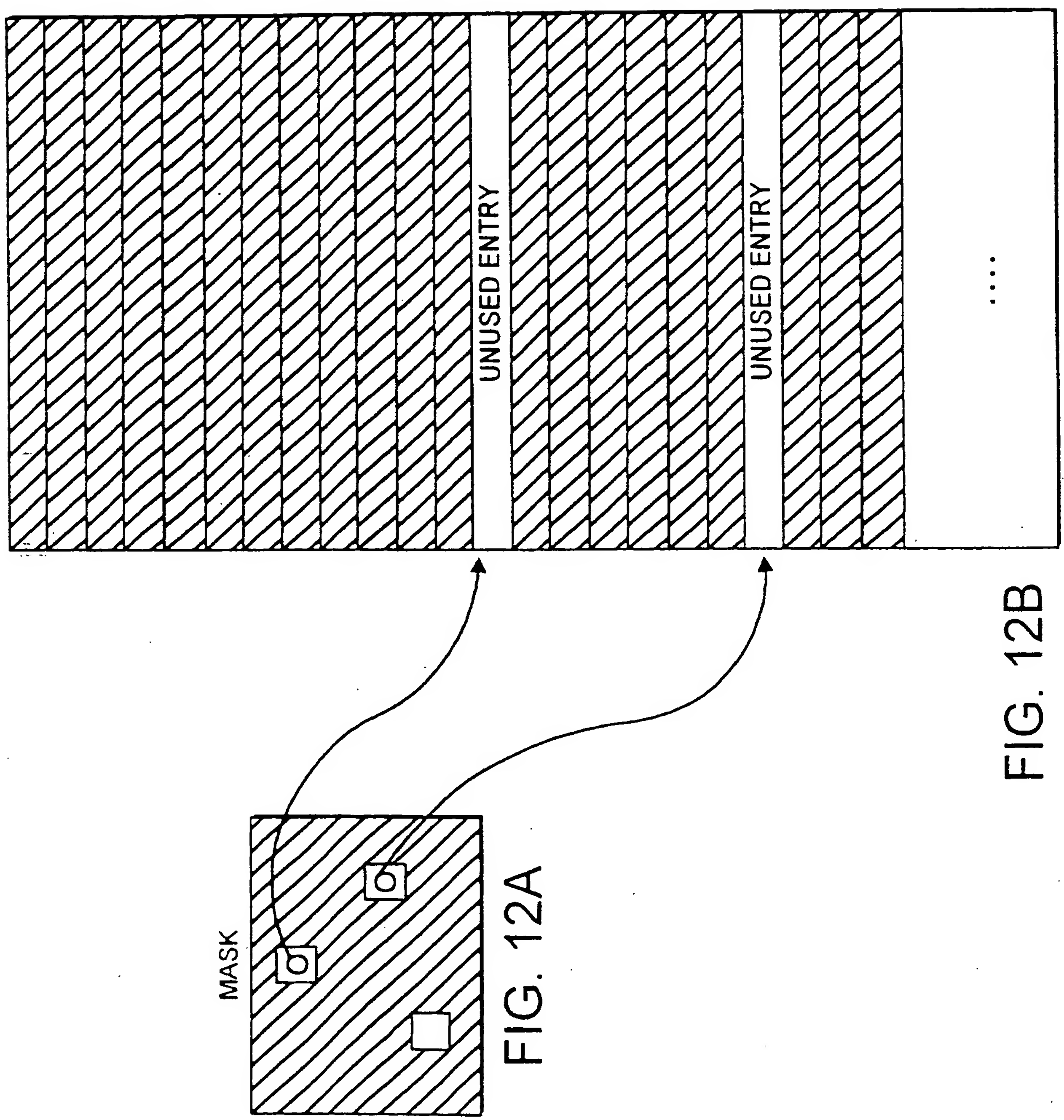


FIG. 12A

FIG. 12B

BIT / BYTE	# BYTES	7	6	5	4	3	2	1	0
	2	HEADER							
	32	TIMECODE							
	.	VIDEO DATA COMPRESSED AND DECIMATED							
		NEXT FRAME / PACKET							

FIG. 14

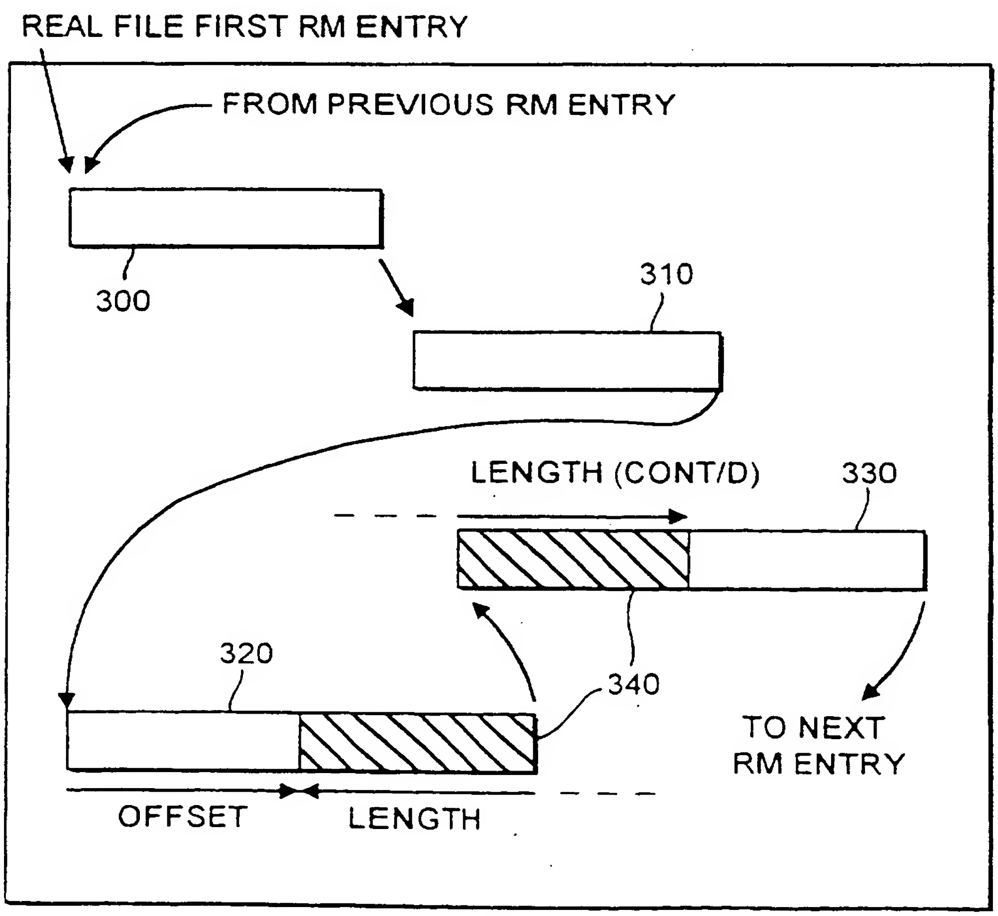


FIG. 15

2312059

DATA STORAGE

This invention relates to data storage.

A data storage medium such as a magnetic or magneto-optical disk medium generally has "header" information to define the location, current use and properties of data files stored on the disk. The header information may typically comprise one or more lengthy tables of entries, each entry relating to a particular logical file or section of the disk.

Similar lengthy tables of entries can occur in data storage applications such as computer databases.

In many cases, the table entries are set up in the order in which the data files are recorded on the disk, or in the case of the database example, the order in which the database entries are loaded into the database. However, when a file or database entry is subsequently deleted, it is often not worth the trouble to shuffle the entire table down to fill the free space vacated by the deleted entry. Thus, after a period of usage, there will tend to be free table entries throughout the table.

Unfortunately, however, searching for such free table entries would involve sequentially reading a good deal of the table every time a new entry is to be added to the table. This data processing and storage medium access overhead is not often worthwhile, and it is easier to add a new table entry to the end of the existing entries than to try to fit it into a vacated space earlier in the table.

This invention provides data storage apparatus having an ordered data array of data items stored on a storage medium, in which deletion of a data item from the array leaves data storage space in which a newly stored data item can be stored, the apparatus comprising means for storing a mask array on the storage medium, the mask array having a respective mask array data entry for each possible data item position in the stored data array, which entry is settable to indicate whether a data item is validly stored at that data array position.

The invention addresses the problems described above by providing a relatively small "mask" array in which one or more data bits at a particular position in the mask array (preferably just one data bit) indicates whether a corresponding position in the data array is free. Thus, to locate the first free entry in the data array, only the much

smaller mask array has to be accessed and examined.

This invention also provides a data storage medium on which an ordered data array of data items is stored, in which deletion of a data item from the array leaves data storage space in which a newly stored data item can be stored, the data storage medium also storing a mask array having a respective mask array data entry for each possible data item position in the stored data array, which entry is settable to indicate whether a data item is validly stored at that data array position.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1 is a schematic diagram of a digital video editing system;

Figure 2 is a schematic diagram of a video store controller;

Figures 3a and 3b schematically illustrate the organisation of data on a disk medium for 525-line standard video and 625-line standard video respectively;

Figure 4 is a schematic table showing the contents of a disk header area;

Figure 5 is a schematic table showing the contents of a disk header file;

Figure 6 is a schematic diagram of a file name table;

Figure 7 is a schematic diagram of a real file header table;

Figure 8 is a schematic diagram of a virtual file header table;

Figure 9 is a schematic diagram of a disk route map;

Figure 10 is a schematic diagram of a video edit table;

Figure 11 is a schematic diagram of an audio edit table;

Figures 12a and 12b are schematic diagrams illustrating the operation of a used mask;

Figure 13 is a schematic diagram of an audio data packet;

Figure 14 is a schematic diagram of a video data packet; and

Figure 15 is a schematic diagram showing the use of the route map and video edit table to define a real file and a virtual file.

Figure 1 is a schematic block diagram of a digital video editing system and associated video storage apparatus.

The system comprises a personal computer (PC) 100, the PC having a cursor control device 110 (e.g. a mouse), a display screen memory 120 and a display screen

130. The PC in the present embodiment is a notebook (portable) computer, the IBM "Thinkpad", in which the PC 100, the cursor control device 110, the display screen memory 120 and the display screen (an LCD screen) are all incorporated into a single portable unit. (In actual fact, the cursor control device 110 in the IBM Thinkpad is a joystick control device). Thus, data communication between the PC and its constituent parts is via the PC's internal buses.

The PC 100 communicates with a video store controller 140 via a SCSI bus, and the video store controller 140 also communicates with a magneto-optical disk 150 via a SCSI bus.

In the present embodiment, the video store controller 140 and the magneto-optical disk 150 are fabricated as a "docking station" on which the notebook computer may sit in use.

The editing system is intended to operate as an off-line non-linear edit controller, in which incoming broadcast quality audio and video signals are subjected to very heavy data compression (to a level well below broadcast standard) and are stored on the magneto-optical disk 150. When one or more sections of source video have been stored on the magneto-optical disk 150, they can be manipulated by the user operating the edit controller to generate an edit decision list (EDL) which is a list of video time codes defining "in-points" and "out-points" of the source material to form successive portions of an output edited video sequence. However, because the video signal stored on the disk 150 are well below broadcast standard, the intention is that the EDL is then exported to be applied to the original video data (as originally supplied to the video store controller 140) for broadcast or distribution.

Figure 2 is a schematic diagram of the video store controller 140 and the magneto-optical disk 150.

The magneto-optical disk 150 is a self-contained unit with a removable disk medium 160, containing the read/write heads and associated circuitry 170, and a processor 180 which attends to the very low-level formatting and data handling on the disk. An example of such a product is the Sony HSD-650 magneto-optical disk drive. With this device, the disk 150 is supplied (from external circuitry) with a "logical block address" (LBA) defining one of a large number of logical data blocks (LBs) on the disk. The actual positioning and formatting of the blocks on the disk

medium 160 is left to the processor 180, so that the disk 150 appears to the outside as a large (in this case, 652 Megabytes) storage medium on which small blocks of storage are individually addressable by the LBAs. The disk 150 communicates with a read/write buffer and control circuit 190 via a SCSI link.

A SCSI interface 200 is provided for communication to and from the notebook PC, and an audio/video (A/V) compression/decompression circuit 210 is provided to compress audio and video data to be written to the magneto-optical disk 150 and to decompress audio and video data which is read from the magneto-optical disk 150. The A/V compressor/decompressor 210 uses known intra-picture compression techniques so that individual pictures can be recovered from the disk without reference to other compressed pictures. Specifically, incoming broadcast quality pictures supplied on an input port 220 are subject to decimation by a factor or about 4:1 horizontally and vertically, and the resulting decimated pictures are compressed using known JPEG compression techniques to produce compressed picture data of about 5 kilobytes per picture. When the pictures are subsequently read from the magneto-optical disk 150, they are subjected only to the JPEG decompression, so that the pictures supplied to the PC for display are of a much smaller (4:1 decimated) size than full-rate video pictures. However, this is not a handicap in this case because the pictures are only to be used for assessing where to make edit decisions; the edit decisions are subsequently applied back (via the EDLs) to the original (uncompressed) video signals.

Although it would be possible for program firmware associated with the read/write buffer and control circuit 190 to handle some of the formatting of audio and video data stored on the disk 150, in fact in the present embodiment this is all handled by the PC 100. Thus, the video store controller 140 is set up to act as a rather "dumb" store controller, which reads or writes data to the disk 150 as directed (at the level of a signal LB address) by the PC 100.

In order to initiate a replay of video data from the magneto-optical disk, the PC 100 downloads to the video store controller an ordered list of LBs to replayed. The video frames stored at these LBs are replayed, decompressed and supplied back to the PC for display in that order. Having said this, the PC will often need to access data stored in the header area of the magneto-optical disk to derive the list of LBs to

be sent to the video store controller.

Thus, the way in which data is written to the magneto-optical disk defines many features of the operation of this embodiment, and so the disk organisation will be described in detail below.

By way of introduction, Figures 3a and 3b schematically illustrate the organisation of data on a disk medium 160 for 525-line standard video and 625-line standard video.

Basically, the disk in each case is divided into a header area, followed by a video data area, followed by an audio data area, followed by a few unused sectors (logical blocks), each sector being 2048 bytes of data. The compression applied to the video and audio data is adjusted for the two line standards so that about 44 to 45 minutes of video and audio material can fit onto a single disk medium.

The header area, video data area and audio data are will be described in detail with reference to Figures 4 to 15 below. Importantly, it is repeated that these areas are formatted in terms of logical block addresses, with the very low level formatting being handled by the disk drive itself. The LB-level formatting is handled by the PC under software control.

Figure 4 is a schematic diagram showing the content of the disk header area of a disk medium.

The header area is 256 sectors (LBs) long, and comprises the following portions:

Disk header:	1 logical block
Real file mask:	1 logical block
Real file name table:	2 logical blocks
Real file header table:	16 logical blocks
Virtual file mask:	1 logical block
Virtual file name table:	2 logical blocks
Virtual file header table:	16 logical blocks
Route Map:	64 logical blocks
Video Edit Table Mask:	1 logical block
Video Edit Table:	64 logical blocks

Audio Edit Table Mask:	1 logical block
Audio Edit Table:	64 logical blocks

Each of these portions will be described in greater detail below.

The disk header file is shown in more detail in Figure 5. Most of the parts of the disk header file are fairly self-explanatory. This file is written when the disk is originally formatted (under PC control), and so contains identification data of the software used, a volume label, data giving the number of real files and "virtual files" on the disk (real files and virtual files will be described below) and data defining the route map (also to be defined below). Finally, one bit is reserved to indicate the line standard of the video data recorded on the disk. A single disk medium 160 is constrained to have **either** 525-line standard video **or** 625-line standard video stored on it; there cannot be a mixture of different video line standards on a single disk medium in this particular embodiment.

The maximum number of data files which can be stored on the disk medium is defined in advance by reserving space for a table of the file names and a table of the file headers. In the present embodiment, the maximum number of files is 255 real files and 255 virtual files.

A "real" file is created when audio/video data is recorded from the input port 220 onto a disk medium 160. The real file consists of a file name, a file header and areas of stored data on the disk medium 160. The location of the stored data on the disk medium is defined (in terms of LBAs) by the file header. Once a real file has been recorded, it is not changed by an editing operation; it can simply be maintained in its existing form or deleted from the disk.

In contrast, a virtual file is created by an editing operation, and consists of a file name and a file header pointing to a video edit table only. The virtual file does not have a permanent association with particular data on a disk, but instead provides, indirectly, a series of pointers to sections of the data contained in one or more real files stored on the disk.

This arrangement actually saves a lot of disk space, by not having to store data twice during an editing operation. For example, if there are three real files stored on the disk and an operator wishes to define an edited output video sequence comprising,

say, 10 seconds from each of the three real files, there is no need to physically copy those portions of the real files into a new output file. Instead, a virtual file is defined which provides pointers to the selected portions within each of the real files. In actual fact, since the header area for the virtual files is reserved in advance, creation of a virtual file actually takes up no additional disk space.

A file name table is provided in the header area for real files, and another similar table for virtual files. These are identical in form, and an example is illustrated schematically in Figure 6.

The file name tables comprise a list of file names (up to 16 characters each), with the position of the file name in the list defining an index (or file number) into the real or virtual file header table. Thus, in the example shown, file number 1 is that file whose file name occupies bytes 17 to 32 in the file name table. The same file number is used to address more detailed information about that file in the file header table to be described below.

Figure 7 is a schematic diagram of a real file header table. The table contains one record for each possible real file which can be stored on the disk. The file header table entry repeats the file name and defines the creation date and time of that file. There then follows the time code for the first frame in that real file, followed by a number of frames contained in the real file.

The next three entries in the file header table relate to fragmentation of the file on the disk, i.e. the data being split between two or more non-contiguous areas of the disk (in terms of LBAs), and these will be described below with reference to Figure 9.

A 64-byte space for textual notes is then provided, followed by two records defining a head and a tail picture from the real file. These pictures are used for display on the PC display screen to characterise and identify the real file in an editing operation. Normally, the head picture would be the very first picture in the file, and the tail picture would be the last picture in the file, but these can be set to different pictures within the file if so desired by the user.

One byte is then allocated to indicate which of four possible audio channels are used in that file, and remaining space in the record is unused.

Therefore, although the route map has yet to be described (see Figure 9 below),

it is reiterated at this stage that the real file header table defines the positions on the disk of real data having a permanent association (at least until the file is deleted) with that file name.

Figure 8 is a schematic diagram of a virtual file header. Several entries in the virtual file header table are identical to those in the real file header table, and so will not be described again.

The main differences are that the virtual file header table entry defines the data to be associated with that virtual file by one or more entries in a video edit table index and one or more entries in an audio edit table index. (As a double check, the total number of frames to be expected is defined, and the time code of the output edit sequence can be preset to a particular value by a time preset word).

The video edit table index and the audio edit table index will be described further below, but briefly they comprise a linked list of table entries each defining a portion within a single respective real file. These are created whenever a user gives a PC command to preview an edited output sequence, to mirror the EDL entries held by the PC. A virtual file corresponding to the appropriate VET entries is also set up at that time (i.e. when an output preview command is initiated).

Thus, by the virtual file header table entry pointing to a first entry in the VET and defining a total number of entries in the VET, this provides a linked list of a particular length defining successive portions of more or more real files.

A virtual file can be opened for replay just like a real file can. In that case, the list of VET entries is obtained from the disk medium 160 and the corresponding portions of the route map derived so that those portions can be replayed from the disk medium in order.

Figure 9 is a schematic diagram of a disk "Route Map".

The Route Map (RM) is a table of records on the disk which are joined together by indexes to form a number of linked lists. Each of these linked lists describes a path or "route" of physical locations on the surface of the media. Each entry in the RM describes a contiguous block of disk sectors or "fragment" and contains the index of another route map record describing the next fragment in a linked sequence. A route is described by starting at one of these fragments and following the chain of Route Map indexes through the Route Map until a record is

reached which has a "Next Record" index value of zero to indicate the end of the route. (The first record in the Route Map (index 0) remains unused to allow the index zero to be used to indicate the end of a route).

Each Real File has a route in the RM which describes where on the media surface the file data resides. In addition to a route for each real file, the Route Map contains another route describing the Free Space on the disk. (The Free Space Route). The start of this Free Space Route is indicated by the Start of Free Space index in the disk header which points to an entry in the RM. The Free Space Route is maintained so that at any time it reflects the current allocation of space on the disk.

When a new file is recorded, data writing takes place along the Free Space Route. When recording has completed the route used by the new file is unlinked from the Free Space Route by adjusting the RM indexes. The Start of Free Space index is then made to point further along the free space route, skipping the route used for the new file. The file header created for the new file contains a pointer to the route describing where file data were written. The last of the free space fragments is usually only partially consumed by the new file. In this case a new entry in the RM is created to describe the remainder of this partially used fragment, and this is linked at the top of the Free Space Route.

When real files are deleted, the routes occupied by these files are returned to the free space route by linking at the end of the free space route. It is important that this linking takes place at the end so that fragmentation does not occur until the disk is nearly full. Pointers to the last fragment in each route are maintained so that these items can be quickly accessed without searching through the linked lists for the final record in the chain.

A count of the total number of entries in the RM is maintained in the Number of Fragments on Disk filed in the disk header. This count is also a measure of the extent of fragmentation of the disk.

Figure 10 is a schematic diagram of a video edit table (VET).

The VET defines one or more video edit operations, in terms of the information required to identify the real file from which the edited portion comes, and the start and length of the portion of the real file which is required by that editing operation. Each entry also contains an index to the next VET entry for that virtual

file.

Rather than defining the start of the edited portion as an offset from the start of the corresponding real file, the VET defines the start with respect to the fragment (or route map entry) in which the edited portion commences. An offset from the start of that fragment is then defined, together with the length of the edited portion in frames. By defining the edited portion in this way, it is not then necessary to refer to the real file header table and to trace through the route map to find the start of that edited portion.

Figure 11 is a schematic diagram of an audio edit table. This is fundamentally similar to the video edit table described above, except that it contains a byte defining audio channel allocations to the left and right output channels in the output material. Each of the four audio channels (1...4) can be assigned individually to the left output channel, the right output channel, both output channels or neither output channel by setting the appropriate bits in the allocation byte.

Figures 12a and 12b illustrate the use of a "used" mask.

Referring back to Figure 4, these masks are provided in the second, fifth, ninth and eleventh sections of the header area, and are referred to there as the "real file mask", "virtual file mask", "VET mask", and the "AET mask".

Each such mask is a short array of data containing one respective data bit to define whether a corresponding entry in an associated table is currently used or unused. For example, the real file mask contains one bit for every entry in the real file main table; the VET mask contains one bit for every entry in the video edit table; and so on.

As described above, the main tables, header tables and edit tables can be used or become free (by deletion of an entry) in a non-sequential order. The "used" masks are employed to indicate very quickly to the PC which entries in these tables are free when a new entry is required (e.g. when a new real file is to be recorded). The masks are maintained on the disk and also in the PC's memory.

Simply, therefore, when a new entry in the table is required, the first bit in the used mask which is set to zero (indicating "unused") is identified, and the bit position of that bit from the start of the used mask provides an index to the free entry in the corresponding table. When that table entry is then used, the corresponding bit in the

used mask is set to logical 1 ("used").

This technique not only saves the time to search through the various tables to seek a free entry, it can also save multiple disk accesses to read the tables (which may be quite lengthy) to search for a free entry.

Figure 13 is a schematic diagram of an audio data packet, which contains the audio data relating to one frame of the corresponding video signal.

The audio data packet defines a header, the time code of the corresponding video frame, followed by the necessary audio samples. The audio data packets have a fixed length (for a particular line standard) so that the position of a particular audio packet with respect to another audio packet in the audio data area can be predicted if the number of offset audio packets from one to another is known.

Similarly, Figure 14 schematically illustrates a video data packet which again contains a header, the time code of a single video frame and the video data for that single frame. Again, for a particular video line standard, all of the video packets are of the same length on the disk.

Finally, Figure 15 is a schematic diagram showing the use of the route map and video edit table to define a real file and a virtual file.

Figure 15 schematically represents the surface of the disk in logical block order from top left to bottom right. Four rectangular sections 300, 310, 320 and 330 represent disk fragments or contiguous data sections on the disk (fragmentation of a real file can occur when a new file is created after previous files have been deleted).

Part sections of the fragments 320 and 330 are deliberately shaded; this will be described further below.

Each fragment 300, 310, 320, 330 corresponds to a single respective entry in the route map. A single route map entry can form part of only one real file, although if a part of fragment is used during creation of a real file, the remaining part is then redefined as a separate, smaller fragment.

The fragments are interlinked by the linked nature of the route map list, where each entry points to the next route map record. Thus, the route map entry corresponding to the fragment 300 contains a pointer to the entry for the fragment 310, which in turn contains a pointer to the entry for the fragment 320 and so on. The entries corresponding to the fragments 300:330 can be in any order on the route

map, and in particular do not need to be consecutively indexed entries.

The four fragments shown in Figure 15 relate to a single real file, and the item entitled "First Entry in Route Map" in the real file header table entry (Figure 7 above) points to the entry corresponding to the fragment 300.

Thus, when the real file is opened to be replayed, the real file header is loaded from the magneto-optical disk to the PC 100, from which the PC obtains the first entry in the RM (in this example, this points to the fragment 300), the number of entries in the RM or number of fragments (in this example, 4) and the last entry in the RM (in this example, this points to the fragment 340).

To replay the real file, audio and video data frames are read first from the fragment 300. At the end of the fragment 300 the next RM entry (for the fragment 310) in the linked list forming the RM is accessed by using the pointer contained in the RM entry for the fragment 300, and the data for the fragment 310 is replayed. This is followed immediately by the fragment 320 and followed by the fragment 330.

Assuming that this real file contains only four fragments, replay will stop at the end of the fragment 330, because at this point (a) the number of replayed fragments will equal the total number of fragments defined in the real file header; and (b) the "last fragment" pointer will point to the fragment 330. However, it is noted that in the route map, the entry for the fragment 330 will still point to the next route map entry to form a contiguous linked list.

A video edit table entry defines a portion within this real file, in particular a shaded portion 340. Thus, in the VET entry, there will be an index to the route map entry corresponding to the fragment 320, an offset value indicating the offset (in frames) from the start of that fragment and a length value (in frames) giving the total length of the section 340. Thus, to replace that item from the VET, the route map entry for the fragment 320 is accessed, and then replay started at a number (equal to the variable "offset") of frames from the start of that fragment. Replay then continues through the linked list of fragments defined by the route map until the required length (in frames) has been replayed.

To replay a virtual file the list of VET entries is obtained from the disk medium 160 by loading the virtual file header which defines the first VET entry and the number of VET entries. Since the VET is a linked list, where each entry points

to a single next entry, the appropriate VET entries for a virtual file can be derived. The route map entries and offsets for each VET entry of the virtual file are then derived (as described above) by the PC and are downloaded to the video store controller to initiate replay from the disk medium.

Similar processing takes place for the audio data using the AET.

So, as far as the video store controller is concerned, it receives an ordered list of LBs on the disk for replay whether the file to be replayed is a real file or a virtual file.

By defining the output edited sequence as a virtual file pointing to linked areas of real data on the disk, replay can be performed in a forwards or reverse direction and at different replay speeds because the whole of the edited output sequence is represented as a single file or a single linked sequence of storage areas. There is no need to open and close individual real files in a particular order to preview the output edited sequence.

Because the virtual files and VET entries are stored on the disk 160, they are retained even at the end of an editing session, and can be opened and replayed during a subsequent use of that disk medium 160 with the editing controller.

The use of the route map also allows a further type of "dummy" file to be created, referred to by the filename "ALL". When this file is opened for replay, the PC simply instructs the video store controller to replay all stored video data on the disk medium, in the order defined by the route map. This allows a user to review the entire contents of a disk medium very easily.

CLAIMS

1. Data storage apparatus having an ordered data array of data items stored on a storage medium, in which deletion of a data item from the array leaves data storage space in which a newly stored data item can be stored, the apparatus comprising means for storing a mask array on the storage medium, the mask array having a respective mask array data entry for each possible data item position in the stored data array, which entry is settable to indicate whether a data item is validly stored at that data array position.

2. Apparatus according to claim 1, in which the data array is a file header table, each data item in the file header table being a file header defining storage locations on the storage medium of a respective data file.

3. Apparatus according to claim 1 or claim 2, in which each mask array data entry comprises one data bit in the mask array.

4. Apparatus according to any one of claims 1 to 3, in which the position in the mask array of each mask array data entry corresponds to the position in the stored data array of the respective possible data item position.

5. Apparatus according to any one of the preceding claims, in which the data storage medium is a disk storage medium.

6. A data storage medium on which an ordered data array of data items is stored, in which deletion of a data item from the array leaves data storage space in which a newly stored data item can be stored, the data storage medium also storing a mask array having a respective mask array data entry for each possible data item position in the stored data array, which entry is settable to indicate whether a data item is validly stored at that data array position.

7. Data storage apparatus substantially as hereinbefore described with reference

to the accompanying drawings.

8. A data storage medium substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

16

Application No: GB 9607692.2
Claims searched: 1 to 8

Examiner: B G Western
Date of search: 23 July 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G4A AMG2 AMX

Int Cl (Ed.6): G06F 3/06 12/02; G11B 20/12 27/031 27/034

Other: On-line : WPI, Inspec, Computer

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB-2218833-A ARDENT N.b. pages 10-14	1 to 6
X	EP-0452884-A2 SONY N.b. pages 4-5	1,3,4,5,6
X	EP-0416445-A2 MICROSOFT N.b. pages 6-8	1 to 6
X	EP-0328240-A2 IBM N.b. pages 3, 16	1,2,5,6
X	P Norton and R Wilton, "The New Peter Norton Programmer's Guide to The IBM PC & PS/2", published 1988, Microsoft Press, pages 118 to 121.	1,2,5,6
X	Dialog record 01373292 of UNIX Review, vol 8, no 10, Oct 1990, Frost L, "UNIX file recovery", p73(7).	1,3,4,5,6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		